News on the Carbon Burning at Astrophysical Energies

S. Courtin[1] for the STELLA collaboration
[1] *IPHC and University of Strasbourg, France*

Fusion reactions play an essential role in understanding the energy production, the nucleosynthesis of chemical elements and the evolution of massive stars. Thus, the direct measurement of key fusion reactions at thermonuclear energies is of very high interest. The carbon burning in stars is essentially driven by the $^{12}C+^{12}C$ fusion reaction. This reaction is known to show prominent resonances at energies ranging from a few MeV/nucleon down to the sub-Coulomb regime, possibly due to molecular ^{12}C-^{12}C configurations in ^{24}Mg [1]. The persistence of such resonances down to the Gamow energy window is an interesting question. This reaction could also be subject to the fusion hindrance phenomenon which has been evidenced for medium mass nuclei and measured in numerous systems [2].

This contribution will discuss recent measurements performed in the $^{12}C+^{12}C$ system at deep sub-barrier energies using the newly developed STELLA apparatus associated with the UK FATIMA detectors for the exploration of fusion cross-sections of astrophysical interest [3]. Gamma-rays have been detected in an array of $LaBr_3$ detectors and protons and alpha particles were identified in double-sided silicon-strip detectors. A novel rotating target system has been developed able to sustain high intensity carbon beams delivered by the Andromede facility of the University Paris-Saclay and IPN-Orsay (France). The gamma-particle coincidence technique as well as nanosecond timing conditions have been used in the analysis in order to minimize background. This has allowed to obtain astrophysical S factors down to the Gamow window which will be presented and discussed in the frame of previous experimental results and theoretical calculations on the deep sub-barrier $^{12}C+^{12}C$ fusion reaction.

[1] D. Jenkins and S. Courtin J. Phys. G: Nucl. Part. Phys. 42 034010 (2015).
[2] C.L. Jiang et al., Phys.Rev. Lett. 89 052701(2002).
[3] M. Heine et al., Nucl. Inst. Methods A 903, 1 (2018).